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UTILITY PATENT APPLICATION TRANSMITTAL

(Only for new nonprovisional applications under 37 CFR 1.53(b)

Attorney Docket No. 42390.P5277 Total Pages 2

First Named Inventor or Application Identifier Hazra, et al.

Express Mail Label No. EM542801139US

ADDRESS TO: **Assistant Commissioner for Patents**
Box Patent Application
Washington, D. C. 20231

APPLICATION ELEMENTS

See MPEP chapter 600 concerning utility patent application contents.

1. X Fee Transmittal Form
   (Submit an original, and a duplicate for fee processing)
2. X Specification (Total Pages 21) Including Title Page
   (preferred arrangement set forth below)
   - Descriptive Title of the Invention
   - Cross References to Related Applications
   - Statement Regarding Fed sponsored R & D
   - Reference to Microfiche Appendix
   - Background of the Invention
   - Brief Summary of the Invention
   - Brief Description of the Drawings (if filed)
   - Detailed Description
   - Claims
   - Abstract of the Disclosure
3. X Drawings(s) (35 USC 113) (Total Sheets 3)
4. X Oath or Declaration (Total Pages 3) Unsigned
   a. ___ Newly Executed (Original or Copy)
   b. ___ Copy from a Prior Application (37 CFR 1.63(d))
   (for Continuation/Divisional with Box 17 completed) **(Note Box 5 below)**
   i. ___ DELETIONS OF INVENTOR(S) Signed statement attached deleting inventor(s) named in the prior application, see 37 CFR 1.63(d)(2) and 1.33(b).
5. ___ Incorporation By Reference (useable if Box 4b is checked)
   The entire disclosure of the prior application, from which a copy of the oath or declaration is supplied under Box 4b, is considered as being part of the disclosure of the accompanying application and is hereby incorporated by reference therein.
6. ___ Microfiche Computer Program (Appendix)
7. ___ Nucleotide and/or Amino Acid Sequence Submission
   (if applicable, all necessary)
   a. ___ Computer Readable Copy
   b. ___ Paper Copy (identical to computer copy)
   c. ___ Statement verifying identity of above copies

ACCOMPANYING APPLICATION PARTS

8. _____ Assignment Papers (cover sheet & documents(s))
9. _____ a. 37 CFR 3.73(b) Statement (where there is an assignee)
   _X_ b. Power of Attorney
10. _____ English Translation Document (if applicable)
11. _X_ a. Information Disclosure Statement (IDS)/PTO-1449
   _X_ b. Copies of IDS Citations
12. _____ Preliminary Amendment
13. _X_ Return Receipt Postcard (MPEP 503) (Should be specifically itemized)
14. _____ a. Small Entity Statement(s)
   b. Statement filed in prior application, Status still proper and desired
15. _____ Certified Copy of Priority Document(s) (if foreign priority is claimed)

16. _X_ Other: Certificate of Mailing, with attorney signature and copy of postcard

17. **If a CONTINUING APPLICATION,** check appropriate box and supply the requisite information:

___ Continuation ____ Divisional ____ Continuation-in-part (CIP)

of prior application No: __

18. **Correspondence Address**

_____ Customer Number or Bar Code Label _____

(Insert Customer No. or Attach Bar Code Label here)

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PTO/SB/17(10/96)
Approved for use through 09/30/98. OMB 0651-0032
Patent and Trademark Office: U.S. DEPARTMENT OF COMMERCE

FEE TRANSMITTAL

EXPRESS MAIL NO. EM542801139US

Complete if Known:
Application No. Not Yet Assigned
Filing Date September 11, 1998
First Named Inventor Rageeb Hazra
Group Art Unit Not Yet Assigned
Examiner Name Not Yet Assigned
Attorney Docket No. 42390.P5277

METHOD OF PAYMENT (check one)

1. [ ] **The Commissioner is hereby authorized to charge indicated fees and credit any over payments to:**

   Deposit Account Number 02-2666
   Deposit Account Name
   [X] **Charge Any Additional Fee Required Under 37 CFR 1.16 and 1.17**

   [ ] **Charge the Issue Fee Set in 37 CFR 1.18 at the Mailing of the Notice of Allowance, 37 CFR 1.131(b)**

2. X **Payment Enclosed**
   X **Check**
   _____ **Money Order**
   _____ **Other**

FEE CALCULATION (fees effective 10/01/97)

1. **FILING FEE**

Large Entity Fee Code	Large Entity Fee ($)	Small Entity Fee Code	Small Entity Fee ($)	Fee Description	Fee Paid
101	790	201	395	Utility application filing fee	790.00
106	330	206	165	Design application filing fee	
107	540	207	270	Plant filling fee	
108	790	208	395	Reissue filing fee	
114	150	214	75	Provisional application filing fee	
				SUBTOTAL (1)	$ 790.00

2. **CLAIMS**

			Extra		Fee from below		Fee Paid
Total Claims	29	– 20 =	9	X	22.00	=	198.00
Independent Claims	4	– 3 =	1	X	82.00	=	82.00
Multiple Dependent Claims				X		=	

Large Entity Fee Code	Large Entity Fee ($)	Small Entity Fee Code	Small Entity Fee ($)	Fee Description	Fee Paid
103	22	203	11	Claims in excess of twenty	198.00
102	82	202	41	Independent claims in excess of 3	82.00
104	270	204	135	Multiple dependent claim	
109	82	209	41	Reissue independent claims over original patent	
110	22	210	11	Reissue claims in excess of 20 and over original patent	
				SUBTOTAL (2)	$ 280.00

FEE CALCULATION (continued)

3. ADDITIONAL FEES

Large Entity Fee Code	Large Entity Fee ($)	Small Entity Fee Code	Small Entity Fee ($)	Fee Description	Fee Paid
105	130	205	65	Surcharge - late filing fee or oath	
127	50	227	25	Surcharge - late provisional filing fee or cover sheet	
139	130	139	130	Non-English specification	
147	2,520	147	2,520	For filing a request for reexamination	
112	920*	112	920*	Requesting publication of SIR prior to Examiner action	
113	1,840*	113	1,840*	Requesting publication of SIR after Examiner action	
115	110	215	55	Extension for response within first month	
116	400	216	200	Extension for response within second month	
117	950	217	475	Extension for response within third month	
118	1,510	218	755	Extension for response within fourth month	
128	2,060	228	1,030	Extension for response within fifth month	
119	310	219	155	Notice of Appeal	
120	310	220	155	Filing a brief in support of an appeal	
121	270	221	135	Request for oral hearing	
138	1,510	138	1,510	Petition to institute a public use proceeding	
140	110	240	55	Petition to revive unavoidably abandoned application	
141	1,320	241	660	Petition to revive unintentionally abandoned application	
142	1,320	242	660	Utility issue fee (or reissue)	
143	450	243	225	Design issue fee	
144	670	244	335	Plant issue fee	
122	130	122	130	Petitions to the Commissioner	
123	50	123	50	Petitions related to provisional applications	
126	240	126	240	Submission of Information Disclosure Stmt	
581	40	581	40	Recording each patent assignment per property (times number of properties)	
146	790	246	395	For filing a submission after final rejection (see 37 CFR 1.129(a))	
149	790	249	395	For each additional invention to be examined (see 37 CFR 1.129(a))	

Other fee (specify) _____ _____

Other fee (specify) _____ _____

SUBTOTAL (3) $ 0.00

*Reduced by Basic Filing Fee Paid

TOTAL AMOUNT OF PAYMENT ($) $ 1070.00

SUBMITTED BY:

Typed or Printed Name: Allan T. Sponsseller

Signature _____ Date September 11, 1998

Reg. Number 38,318 Deposit Account User ID _____ (complete if applicable)

"Express Mail" mailing label number EM542801139US
Date of Deposit September 11, 1998
I hereby certify that I am causing this paper or fee to be deposited with the United States Postal Service "Express Mail Post Office to Addressee" service on the date indicated above and that this paper or fee has been addressed to the Assistant Commissioner for Patents, Washington, D.C. 20231
Signature 9-11-98 Date

APPLICATION FOR UNITED STATES LETTERS PATENT

FOR

CANNED 10

METHOD AND SYSTEM FOR VIDEO FRAME ENHANCEMENT USING EDGE DETECTION

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METHOD AND SYSTEM FOR VIDEO FRAME ENHANCEMENT USING EDGE DETECTION

BACKGROUND

Field

The present invention relates to video coding and/or decoding and, more particularly, to using edge detection to enhance video frames after coding/decoding.

Background Information

As is well-known, transform-based video coding and/or decoding introduces artifacts in the decoded video frames, such as blocking, ringing, etc. Lower bit-rate video coding and/or decoding typically results in increased visibility of these coding artifacts. In this context, Post-processing may be used to reduce the visibility of the coding artifacts; however, a need exists for improving the effectiveness of these post-processing techniques.

SUMMARY

Briefly, in accordance with one embodiment of the invention, a video processing system includes: a video coder. The video coder includes the capability to generate an edge detection map along a predetermined direction for an uncoded frame that is to be coded.

Briefly, in accordance with another embodiment of the invention, an article includes: a

storage medium having stored thereon instructions capable of being executed by a system that when executed result in: producing an edge detection map along a predetermined direction from the video frame prior to coding; and coding the edge detection map and the video frame.

Briefly, in accordance with one more embodiment of the invention, a method of processing a video frame includes: producing an edge detection map along a predetermined direction from the video frame prior to coding; and coding the edge detection map and the video frame.

Briefly, in accordance with still one more embodiment of the invention, a video processing system includes: a video frame processor to generate an edge detection map from an uncoded video frame to be coded, the video frame processor further including the capability to code the edge detection map.

BRIEF DESCRIPTION OF THE DRAWINGS

The subject matter regarded as the invention is particularly pointed out and distinctly claimed in the concluding portion of the specification. The invention, however, both as to organization and method of operation, together with objects, features, and advantages thereof, may best be understood by reference to the following detailed description when read with the accompanying drawings in which:

FIG. 1 is a block diagram illustrating an embodiment of a system for coding and/or decoding video

frames using edge detection in accordance with the invention;

FIG. 2 is a block diagram of an embodiment of a prior art system for coding and/or decoding video frames using edge detection; and

FIG. 3 is a flowchart illustrating an embodiment of a process for producing an embodiment of an edge detection map in accordance with the present invention.

DETAILED DESCRIPTION

In the following detailed description, numerous specific details are set forth in order to provide a thorough understanding of the invention. However, it will be understood by those skilled in the art that the present invention may be practiced without these specific details. In other instances, well-known methods, procedures, components and circuits have not been described in detail so as not to obscure the present invention.

As previously indicated, low bit-rate video coding and/or decoding increases the visibility of coding artifacts, but post-processing may be employed to reduce the visibility of these artifacts. Typically, coding is employed to compress images for transmission over a limited bandwidth communications channel, although, not always, and, of course, the invention is not limited in scope in this respect. Post-processing techniques, in general, attempt a balance between blurring, introduced by filtering coded artifacts from the video frame, and the visibility of these artifacts in

the displayed video frame or image. Examples of such post-processing includes proposed techniques for coding noise removal for MPEG-4 video ISO/IEC 14496-2 and similar approaches suggested for H.263+, ITU-T Recommendation Version 2, 1998, both available from the International Telecommunications Union (ITU). Typically, these techniques have drawbacks, however.

At times, signal information about spatial detail in the original video frame is not correctly inferred. This may occur because local image edge detection is performed on the decoded video frame, as illustrated in FIG. 2, for example, and typically high frequency signal information has been attenuated due to quantization and other processing performed to code or compress the video frame. Moreover, compression artifacts may manifest themselves as "spurious" signal information with fine spatial detail, confusing the inference process. For example, as illustrated by embodiment 200 in FIG. 2, after coding the video frame, as illustrated by block 220, the coded signals are transmitted via a communications channel(not shown). For example, this communications system may be a wireline or wireless communications system, it may be point-to-point, broadcast, multi-cast, packet-switched, or circuit-switched, to provide a few examples. Then, as illustrated by block 230, the video frame is decoded at the far end from the received signals and edge detection is performed on the decoded frame, as illustrated by block 240. Edge

detection signal information is provided, along with the decoded frame, in this example, to perform edge sensitive post-filtering, as indicated by block 250, which may ultimately produce an enhance video frame 260. However, because in this example, the edge detection information is generated from the decoded or decompressed frame, high frequency signal information may have been attenuated in the decoded frame, resulting in lower quality edge detection signal information being produced.

Another disadvantage associated with these approaches is that the post-processing techniques employed are typically computationally complex and may impose a burden at the far end of the communications channel. Typically, this complexity is increased as a result of compression induced coding noise present in the edge detection phase and/or the difficulty of generating local edge signall information from the decoded video frame.

Although the invention is not limited in scope to the embodiment illustrated in FIG. 1, embodiment 100, as one example, addresses these drawbacks. Video quality improvement provided by post- processing may be increased by making available to the post-processor reliable signal information about object edges in the video frame. This may be accomplished by using signal information generated prior to video coding. This signal information may then be employed to adapt or modify the filtering effects in regions with different degrees of spatial detail, as

explained in more detail below. Furthermore, the computational complexity of post-processing is decreased, relatively speaking, since edge signal information is not generated during post-processing, in comparison with alternative approaches.

Referring now to FIG. 1, embodiment 100 is a block diagram illustrating an embodiment of a video processing system in accordance with the present invention. As illustrated, this embodiment includes a video coder, including the capability to generate an edge detection map along a predetermined direction for an uncoded frame that is to be coded. Therefore, for the embodiment illustrated in FIG. 1, it is assumed that the edge detection is performed as part of the video coding, although the invention is not limited in scope in this respect. It will, of course, be appreciated, that the invention is not limited in scope to use with any particular form of coding and/or decoding. For example, MPEG-4, H.263+, or any one of a number of other approaches may be employed. The edge detection signal information in this embodiment that will be employed for post-processing, however, in this embodiment, is obtained using the original video frame, in comparison with alternative approaches. Therefore, as illustrated in FIG. 1, edge detection processing 120 is applied to video frame 110 before the video frame is coded, as indicated by block 130. For video frames in YUV color space format, also referred to as YCrCb format, an edge detection map may be produced from one of the two chroma planes, that is U or

V, to utilize a correlation between edges in the chroma plane and physical object edges, although the invention is not limited in scope in this respect, or to the use of video frames in YUV color space format. More specifically, many other formats may be employed, and, even where the YUV color space format is employed, many other approaches to edge detection may be employed. However, for this particular embodiment, this process produces a binary-edge mask or edge detection map, as detailed below.

The edge detection is done along a predetermined direction in this embodiment. The horizontal direction and the vertical direction may be utilized, although the invention is not limited in scope in this respect. Therefore, any direction may be employed, such as, for example, the diagonal direction. Likewise, one, two, or more edge detection maps may be employed. Of course, more edge-detection maps should produce better results, but at a greater cost in terms of resources. For example, where the edge detection maps are to be transmitted, both computational resources and bandwidth resources are consumed. Edge detection is performed on a pixel-by-pixel basis for a given video frame in this particular embodiment, although, again, the invention is not restricted in scope in this respect. It is, of course, assumed, for this particular embodiment, that the video frame comprises a digital image with each pixel location having color space signal information in a binary digital signal format, although the invention is not limited in

scope in this respect. Of course, any one of a number of color space coordinate systems may be used, and the invention is not limited in scope to a particular color space coordinate system. Furthermore, the invention is not limited in scope to employing video frames having color space signal information and, therefore, a gray scale image may, likewise, be processed in this manner, for example. Furthermore, any storage format may be employed to store the associated signals.

In one embodiment, traditional techniques of image processing, such as, for example, the LAPLACIAN edge detection matrix may be applied, although the invention is not limited in scope in this respect. As is well-known, the effect of applying this matrix is to sharpen the edges present in the video frame along a particular direction. Of course, any one of a number of other approaches for signal detection may alternatively or in addition be employed. For example, although the invention is not limited in scope in this respect, a variety of well-known operators for use in signal processing are described in Section 7.4, Spatial Operations, and in Section 7.4, Edge Detection, of the Textbook Fundamentals of Digital Image Processing by Anil Jain, published by Prentice Hall, ISBN: 0133361659. Once the LAPLACIAN has been applied on a pixel-by-pixel basis to the video frame, this produces a frame of signal values. Thresholding may then be applied to each pixel and, depending upon whether the signal value in a particular pixel location exceeds the threshold or not, a binary signal value may be assigned to that location. Of course, alternative

techniques other than simple thresholding may also be employed. In this particular embodiment, this frame or matrix of binary values comprises the binary-edge mask or edge detection map. As illustrated in FIG. 1 by block 140, this edge detection map may then be coded or compressed for transmission via a communications channel. The process described above for this particular embodiment is illustrated in FIG. 3, although the invention is not limited in scope in this respect.

Although the invention is not limited in scope in this respect, it is envisioned that an edge detection map may be transmitted as supplemental signal information corresponding to a coded video frame. Therefore, at the far or receiving end of the communications channel, depending upon the capabilities of the decoder, this edge detection map may or may not be employed to enhance the decoded video frame, as described in more detail for this embodiment below. Likewise, in addition to transmitting one edge detection map, in alternative embodiments, multiple edge detection maps may be transmitted, as previously indicated. For example, in this particular embodiment, a horizontal and a vertical edge detection map may be transmitted. Therefore, the previously described edge detection process would be applied to the video frame to produce a horizontal edge detection map and to produce a vertical edge detection map. Of course, in this embodiment, the LAPLACIAN to be applied is modified to reflect the direction in which the edge detection is performed.

It is noted that although in this particular embodiment the edge detection processing is performed in a spatial domain, the invention is not limited in scope in this respect. Edge detection processing may be performed in any suitable domain desired. For example, a video frame may be transformed to the frequency domain and high frequency signal information may be extracted to perform the desired edge detection. Once this has occurred, an inverse transformation back to the spatial domain may take place and the edge detection map may be produced and coded for transport via a communications channel.

It is, likewise, noted that any one of a number of coding or compression schemes may also be employed to compress the edge detection map. For example, a lossy or lossless compression scheme may be employed. It will appreciated that the choice of compression scheme may vary with a variety of factors, such as available bandwidth, available processing capability, etc. As one example, differential encoding, such as DPCM encoding, may be employed. Again, the invention is not limited in scope to any in particular coding and/or compression scheme.

Once the encoded video frame and edge detection map have been received at the far end of the communications channel, they may be decoded to produce a representation of the original vide frame and a representation of the originally generated edge detection map. Typically, the inverse of the process performed to code or compress the video frame and edge detection map is

performed in order to decode or decompress the video frame and edge detection map.

In addition to applying this technique to transit video frames via a communications channel and enhance the received coded video frame, this technique may also be employed to store video frames for playback, in an alternative embodiment. In such an embodiment, of course, the video frame and edge detection map after coding are not transmitted via a communications channel, nonetheless, they may be stored, such as on a hard drive or other storage medium and then may be read when it is desired to view the video frame. An advantage of this approach is better utilization of limited storage capacity. The processing employed in this particular embodiment may, therefore, be substantially similar to that employed in an embodiment in which transmission via a communications channel occurs. It is also appreciated that, although in one embodiment edge detection signal information, such as an edge detection map, may be transmitted separately, likewise, it may be transmitted as part of a coded bit stream for the associated video frame in an alternative embodiment. Therefore, in a playback system, an edge detection map may be stored with or separately from the associated video frame. Many such transmission or storage possibilities are available.

Once the video frame and edge detection map have been decoded, one or more edge detection maps may be employed to make determinations regarding post-filtering of the decoded

video frame. For example, in one embodiment, a sharpening or high pass filter may be applied on a pixel-by-pixel basis to those pixels indicating edge signal information in the corresponding edge detection map of the video frame. More specifically, in this particular embodiment, if vertical edge signal information is indicated, then a one-dimensional vertical sharpening filter may be applied to the pixel. If horizontal edge detection signal information is indicate, then a one-dimensional horizontal sharpening filter is applied, and if both horizontal and vertical edge signal is indicate, then a two-dimensional sharpening filter is applied. For example, the edge detection maps each contain bits in particular locations. These bits provide information at the far end regarding the presence of edges in the original frame. This signal information may now be used at the far end to apply sharpening filters to enhance the edges in selected locations, in this embodiment. In this particular embodiment, the sharpening filter comprises the LAPLACIAN, as previously described, or a scaled version of the LAPLACIAN. However, the invention is not limited in scope in this respect. Any one of a number of sharpening filters may be applied, such as those provided in the previously referenced text Fundamentals of Digital Image Processing. Furthermore, instead of a sharpening filter, a smoothing filter may alternatively be applied, depending upon the embodiment, as indicated below, for example. Furthermore, in an alternative embodiment, the user may select a desired amount of smoothing and/or sharpening and, depending upon the user selection,

different amounts of smoothing and/or sharpening may be applied to the video frame based, at least in part, on the edge detection map received and decoded. For example, although the invention is not limited in scope in this respect, a sliding scale may be implemented in software that provides the user the ability to modify the smoothing and/or sharpening and observe the results on the video frame or frames to select the amount that is pleasing to the user for that situation.

As previously indicated, depending upon the processing capability at the far end, the edge signal information may be ignored or different amounts of processing may be employed. For example, although in one embodiment, to decode or upsample the edge detection map a simple sero-order hold interpolation filter may be employed, more sophisticated interpolation processing may be employed based on the edge detection map and depending upon the processing capability at the far end. Presence of this additional information in the form of one or more edge detection maps, of course, in no way inhibits the capability to decode the compressed video frame at the far end of the communications channel. For example, in one embodiment, a coded bit stream may be provided in which the coded edge detection map signal information is provided with the coded frame in a layered approach so that the where greater processing and/or bandwidth capability exists, greater amounts of signal information may be received and employed to perform the video

frame processing.

Many alternative embodiments in accordance with the invention are possible, and the invention is not restricted in scope to any one particular embodiment. For example, embodiments may include a video processing system, a method of processing a video frame, and a storage medium have instructions stored thereon that when executed by a system, such a personal computer, for example, results in an embodiment of a method of processing a video frame in accordance with the present invention being executed.

While certain features of the invention have been illustrated and described herein, many modifications, substitutions, changes, and equivalents will now occur to those skilled in the art. It is, therefore, to be understood that the appended claims are intended to cover all such modifications and changes as fall within the true spirit of the invention.

Claims:

1. A video processing system comprising:

a video coder, the video coder including the capability to generate an edge detection map along a predetermined direction for an uncoded frame that is to be coded.

2. The video processing system of claim 1, wherein the video coder includes the capability to also compress the edge detection map.

3. The video processing system of claim 1, wherein the predetermined direction comprises one of the vertical and horizontal direction.

4. The video processing system of claim 1, and further comprising a video decoder.

5. The video processing system of claim 4, wherein the video decoder includes an edge-sensitive post-filter, the edge-sensitive post-filter including the capability to enhance a decoded video frame based, at least in part, on a decoded edge detection map associated with the decoded frame.

6. A video processing system comprising:

a video frame processor to generate an edge detection map from an uncoded video frame to be coded, the video frame processor further including the capability to code the edge detection map.

7. The video processing system of claim 6, wherein the video processing system includes the capability to code the edge detection map for transmission via a communications channel along with an associated coded video frame.

8. The video processing system of claim 6, wherein the video processing system includes the capability to code the edge detection map for transmission via a communications channel separately from an associated coded video frame.

9. The video processing system of claim 6, wherein the video processing system includes the capability to code the edge detection map for storage along with an associated coded video frame.

10. The video processing system of claim 6, wherein the video processing system includes the capability to code the edge detection map for storage separately from an associated coded video frame.

11. A method of processing a video frame comprising:

producing an edge detection map along a predetermined direction from the video frame prior to coding;

coding the edge detection map and the video frame.

12. The method of claim 11, wherein the predetermined direction comprises one of a horizontal direction and a vertical direction.

13. The method of claim 11, wherein producing an edge detection map includes producing more than one edge detection map along more than one direction; and

wherein coding includes coding the more than one edge detection map.

14. The method of claim 13, and further comprising:

decoding the coded edge detection maps and video frame.

15. The method of claim 14, wherein decoding includes applying an edge-sensitive post-filter, the edge-sensitive post-filter including the capability to enhance a decoded video frame based, at least in part, on decoded edge detection maps associated with the decoded frame.

16. The method of claim 11, and further comprising:

decoding the coded edge detection map and video frame.

17. The method of claim 16, wherein decoding includes applying an edge-sensitive post-filter, the edge-sensitive post-filter including the capability to enhance a decoded video frame based, at least in part, on a decoded edge detection map associated with the decoded frame.

18. The method of claim 17, and further comprising: storing the coded video image and edged detection map before decoding.

19. The method of claim 17, and further comprising: transmitting the coded video image and edge detection map via a bandwidth limited communications channel prior to decoding.

20. An article comprising: a storage medium having stored thereon instructions capable of being executed by a system that when executed result in:

producing an edge detection map along a predetermined direction from the video frame prior to coding;

coding the edge detection map and the video frame.

21. The article of claim 20, wherein the predetermined direction comprises one of a horizontal direction and a vertical direction.

22. The article of claim 20, wherein producing an edge detection map includes producing more than one edge detection map along more than one direction; and

wherein coding includes coding the more than one edge detection map.

23. The article of claim 22, and further comprising:

decoding the coded edge detection maps and video frame.

24. The article of claim 23, wherein decoding includes applying an edge-sensitive post-filter, the edge-sensitive post-filter including the capability to enhance a decoded video frame based, at least in part, on decoded edge detection maps associated with the decoded frame.

25. The method of claim 23, wherein decoding includes applying an edge-sensitive post-filter, the edge-sensitive post-filter including the capability to enhance a decoded video frame based, at

least in part, on decoded edge detection maps associated with the decoded frame.

26. The method of claim 20, and further comprising:

decoding the coded edge detection map and video frame.

27. The method of claim 26, wherein decoding includes applying an edge-sensitive post-filter, the edge-sensitive post-filter including the capability to enhance a decoded video frame based, at least in part, on a decoded edge detection map associated with the decoded frame.

28. The method of claim 27, and further comprising: storing the coded video image and edged detection map before decoding.

29. The method of claim 27, and further comprising: transmitting the coded video image and edge detection map via a bandwidth limited communications channel prior to decoding.

Abstract

Briefly, in accordance with one embodiment of the invention, a video processing system includes: a video coder. The video coder includes the capability to generate an edge detection map along a predetermined direction for an uncoded frame that is to be coded.

Briefly, in accordance with another embodiment of the invention, an article includes: a storage medium having stored thereon instructions capable of being executed by a system that when executed result in: producing an edge detection map along a predetermined direction from the video frame prior to coding; and coding the edge detection map and the video frame.

Briefly, in accordance with one more embodiment of the invention, a method of processing a video frame includes: producing an edge detection map along a predetermined direction from the video frame prior to coding; and coding the edge detection map and the video frame.

Briefly, in accordance with still one more embodiment of the invention, a video processing system includes: a video frame processor to generate an edge detection map from an uncoded video frame to be coded, the video frame processor further including the capability to code the edge detection map.

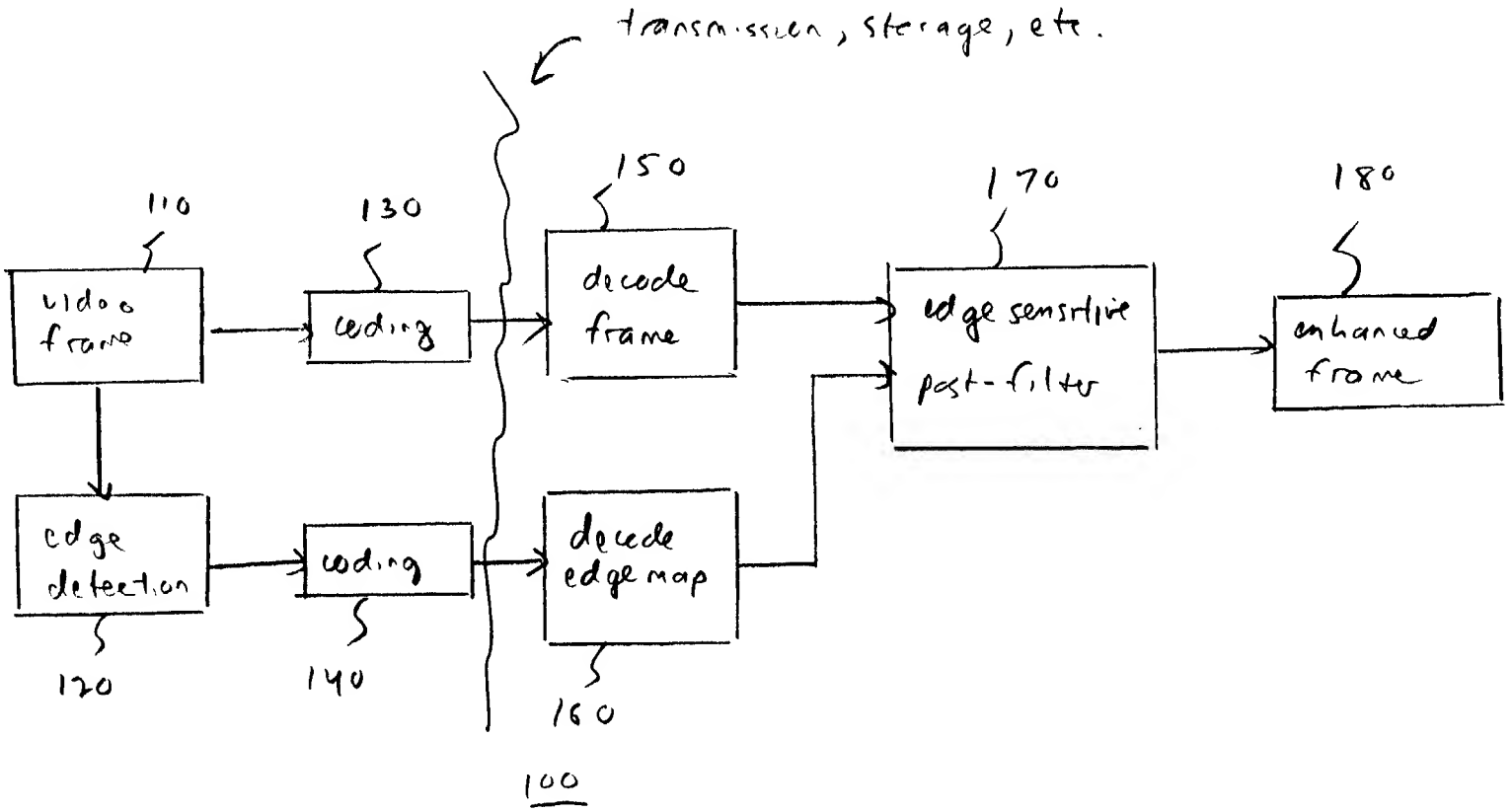

FIG. 1

P5277

Sheet 1 of 3 Sheets

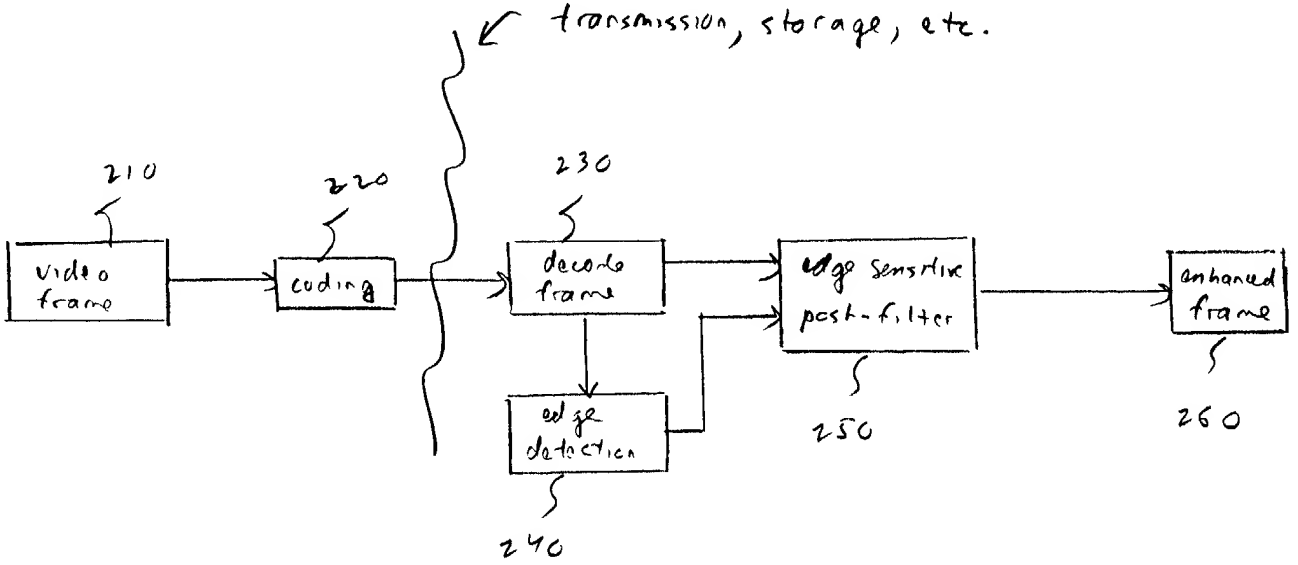

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FIG 2

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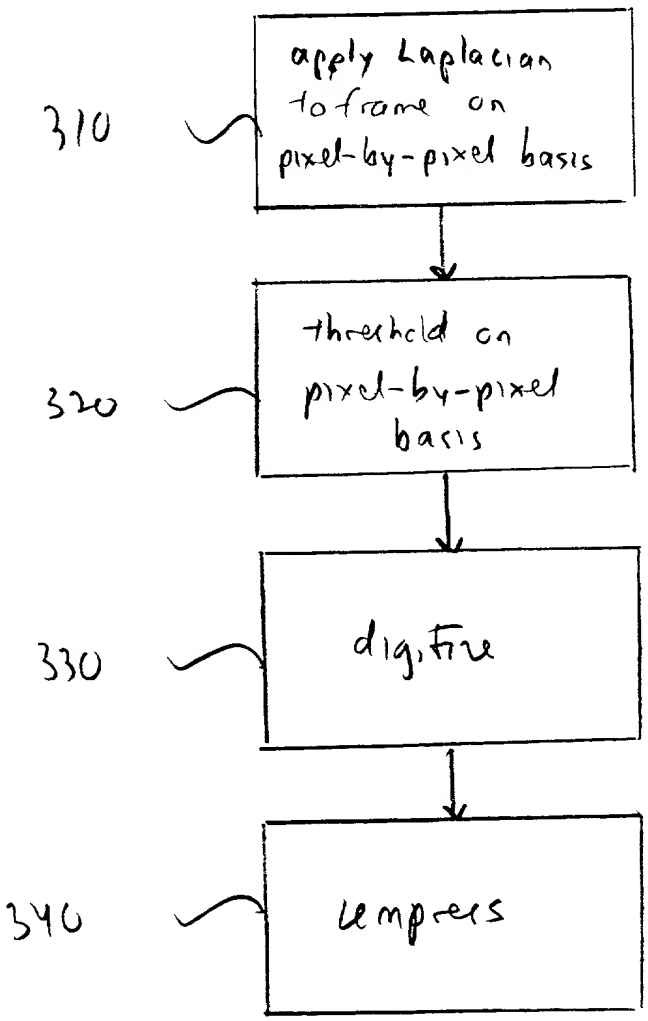

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FIG. 3

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Attorney's Docket No.: 42390.P5277 PATENT

DECLARATION AND POWER OF ATTORNEY FOR PATENT APPLICATION
(FOR **INTEL CORPORATION** PATENT APPLICATIONS)

As a below named inventor, I hereby declare that:

My residence, post office address and citizenship are as stated below, next to my name.

I believe I am the original, first, and sole inventor (if only one name is listed below) or an original, first, and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled

METHOD AND SYSTEM FOR VIDEO FRAME ENHANCEMENT USING EDGE DETECTION

the specification of which

_X_ is attached hereto.
___ was filed on _____ as
United States Application Number _____
or PCT International Application Number _____
and was amended on _____.
(if applicable)

I hereby state that I have reviewed and understand the contents of the above-identified specification, including the claim(s), as amended by any amendment referred to above. I do not know and do not believe that the claimed invention was ever known or used in the United States of America before my invention thereof, or patented or described in any printed publication in any country before my invention thereof or more than one year prior to this application, that the same was not in public use or on sale in the United States of America more than one year prior to this application, and that the invention has not been patented or made the subject of an inventor's certificate issued before the date of this application in any country foreign to the United States of America on an application filed by me or my legal representatives or assigns more than twelve months (for a utility patent application) or six months (for a design patent application) prior to this application.

I acknowledge the duty to disclose all information known to me to be material to patentability as defined in Title 37, Code of Federal Regulations, Section 1.56.

I hereby claim foreign priority benefits under Title 35, United States Code, Section 119(a)-(d), of any foreign application(s) for patent or inventor's certificate listed below and have also identified below any foreign application for patent or inventor's certificate having a filing date before that of the application on which priority is claimed:

Prior Foreign Application(s)			Priority Claimed	
(Number)	(Country)	(Day/Month/Year Filed)	Yes	No
(Number)	(Country)	(Day/Month/Year Filed)	Yes	No
(Number)	(Country)	(Day/Month/Year Filed)	Yes	No

I hereby claim the benefit under title 35, United States Code, Section 119(e) of any United States provisional application(s) listed below

(Application Number) Filing Date

I hereby claim the benefit under Title 35, United States Code, Section 120 of any United States application(s) listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States application in the manner provided by the first paragraph of Title 35, United States Code, Section 112, I acknowledge the duty to disclose all information known to me to be material to patentability as defined in Title 37, Code of Federal Regulations, Section 1.56 which became available between the filing date of the prior application and the national or PCT international filing date of this application:

(Application Number)	Filing Date	(Status -- patented, pending, abandoned)
(Application Number)	Filing Date	(Status -- patented, pending, abandoned)

I hereby appoint Farzad E. Amini, Reg. No. P42,261; Aloysius T. C. AuYeung, Reg. No. 35,432; Amy M. Armstrong, Reg. No. P42,265; William Thomas Babbitt, Reg. No. 39,591; Carol F. Barry, Reg. No. P41,600; Jordan Michael Becker, Reg. No. 39,602; Bradley J. Bereznak, Reg. No. 33,474; Michael A. Bernadicou, Reg. No. 35,934; Roger W. Blakely, Jr., Reg. No. 25,831; Gregory D. Caldwell, Reg. No. 39,926; Kent M. Chen, Reg. No. 39,630; Lawrence M. Cho, Reg. No. 39,942; Yong S. Choi, Reg. No. P43,324; Thomas M. Coester, Reg. No. 39,637; Roland B. Cortes, Reg. No. 39,152; Barbara Bokanov Courtney, Reg. No. P42,442; Michael Anthony DeSanctis, Reg. No. 39,957; Daniel M. De Vos, Reg. No. 37,813; Robert Andrew Diehl, Reg. No. 40,992; Tarek N. Fahmi, Reg. No. 41,402; James Y. Go, Reg. No. 40,621; Richard Leon Gregory, Jr., P42,607; Dinu Gruia, Reg. No. P42,996; David R. Halvorson, Reg. No. 33,395; Thomas A. Hassing, Reg. No. 36,159; Phuong-Quan Hoang, P41,839; Willmore F. Holbrow III, Reg. No. P41,845; George W Hoover II, Reg. No. 32,992; Eric S. Hyman, Reg. No. 30,139; Dag H. Johansen, Reg. No. 36,172; William W. Kidd, Reg. No. 31,772; Tim L. Kitchen, Reg. No. P41,900; Michael J. Mallie, Reg. No. 36,591; Andre L. Marais, under 37 C.F.R. § 10.9(b); Paul A. Mendonsa, Reg. No. 42,879; Darren J. Milliken, 42,004; Thinh V. Nguyen, P42,034; Kimberley G. Nobles, Reg. No. 38,255; Michael A. Proksch, Reg. No. 43,021; Babak Redjaian, P42,096; James H. Salter, Reg. No. 35,668; William W. Schaal, Reg. No. 39,018; James C. Scheller, Reg. No. 31,195; Anand Sethuraman, Reg. No. P43,351; Charles E. Shemwell, Reg. No. 40,171; Maria McCormack Sobrino, Reg. No. 31,639; Stanley W. Sokoloff, Reg. No. 25,128; Allan T. Sponseller, Reg. No. 38,318; Geoffrey T. Staniford, P43,151; Judith A. Szepesi, Reg. No. 39,393; Vincent P. Tassinari, Reg. No. P42,179; Edwin H. Taylor, Reg. No. 25,129; George G. C. Tseng, Reg. No. 41,355; Lester J. Vincent, Reg. No. 31,460; John Patrick Ward, Reg. No. 40,216; Stephen Warhola, Reg. No. P43,237; Ben J. Yorks, Reg. No. 33,609; and Norman Zafman, Reg. No. 26,250; my attorneys, of BLAKELY, SOKOLOFF, TAYLOR & ZAFMAN LLP, with offices located at 12400 Wilshire Boulevard, 7th Floor, Los Angeles, California 90025, telephone (310) 207-3800, and Alan K. Aldous, Reg. No. 31,905; Robert D. Anderson, Reg. No. 33,826; Joseph R. Bond, Reg. No. 36,458; Richard C. Calderwood, Reg. No. 35,468; Cynthia Thomas Faatz, Reg No. 39,973; Sean Fitzgerald, Reg. No. 32,027; Seth Z. Kalson, Reg. No. 40,670; David J. Kaplan, Reg. No. 41,105; Leo V. Novakoski, Reg. No. 37,198; Naomi Obinata, Reg. No. 39,320; Thomas C. Reynolds, Reg. No. 32,488; Steven P. Skabrat, Reg. No. 36,279; Howard A. Skaist, Reg. No. 36,008; Steven C. Stewart, Reg. No. 33,555; Raymond J. Werner, Reg. No. 34,752; and Charles K. Young, Reg. No. 39,435; my patent attorneys, and Jeffrey S. Draeger, Reg. No. 41,000; Thomas Raleigh Lane, Reg. No. P42,781; Calvin E. Wells, Reg. No. P43,256; and Alexander Ulysses Witkowski, Reg. No. P43,280; my patent agents, of INTEL CORPORATION; and James R. Thein, Reg. No. 31,710, my patent attorney; with full power of substitution and revocation, to prosecute this application and to transact all business in the Patent and Trademark Office connected herewith.

Send correspondence to Howard A. Skaist, Intel,
(Name of Attorney or Agent)
BLAKELY, SOKOLOFF, TAYLOR & ZAFMAN LLP, 12400 Wilshire Boulevard, 7th Floor, Los Angeles, California 90025 and direct telephone calls to Howard A. Skaist, Intel, (503)264-1421.
(Name of Attorney or Agent)

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

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Inventor's Signature _____ Date _____

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